

Comparative Study between Biodegradable Screw and Titanium Interference Screw used During Arthroscopic Reconstruction of Anterior Cruciate Ligament Tear

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Abstract:

Background: Anterior cruciate ligament (ACL) reconstruction is the standard treatment for complete ACL tears, with interference screw fixation being the most widely used tibial fixation method. Titanium screws are known for strong fixation and durability but pose challenges during revision and may interfere with imaging. Biodegradable screws eliminate long-term hardware complications and are MRI-compatible but are associated with risks such as inflammatory reactions, cyst formation, and unpredictable degradation.

Aim and Objectives: This study aimed to compare the clinical and functional outcomes of titanium and biodegradable interference screws in arthroscopic ACL reconstruction, with assessment by Lysholm Knee Score and International Knee Documentation Committee (IKDC) grading. Complications such as effusion, stiffness, infection, and screw-related issues were also documented.

Methods: A total of 60 patients undergoing ACL reconstruction were enrolled and randomly divided into two groups: Group A (biodegradable screw, n = 30) and Group B (titanium screw, n = 30). Pre- and post-operative evaluations included range of motion, Lachman test, anterior drawer test, Lysholm scoring, and IKDC grading. Demographic, clinical, and injury-related characteristics were analyzed to ensure comparability.

Results: Both groups showed significant post-operative improvement in knee stability and function. In Group A, 67% achieved an "Excellent" Lysholm score and 87% were graded as "Normal" or "Nearly Normal" by IKDC. In Group B, 70% scored "Excellent" and 90% were classified as "Normal" or "Nearly Normal." Stability tests (Lachman and anterior drawer) showed high rates of negative results in both groups, with titanium screws demonstrating marginally higher stability. Complications were minimal and comparable: effusion was slightly more frequent in Group A, while stiffness and minor infections were more common in Group B. No screw breakage was reported in either group.

Conclusion: Both biodegradable and titanium interference screws are safe and effective for ACL reconstruction, with no statistically significant differences in functional outcomes. Titanium screws offer slightly higher stability and fewer inflammatory issues, while biodegradable screws remain advantageous in patients requiring future revision or MRI evaluation. The choice of implant should therefore be tailored to patient needs, surgeon preference, and long-term goals.

Keywords: ACL Reconstruction, Titanium Interference Screw, Biodegradable Screw, Arthroscopy, Lysholm Score, IKDC, Graft Fixation.

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Introduction

The anterior cruciate ligament (ACL) is a vital stabilizer of the knee, preventing anterior translation and rotational instability of the tibia relative to the femur. Injury to the ACL often results in joint instability, impaired function, and predisposes patients to meniscal damage and early osteoarthritis if untreated. [1-3] ACL tears are among the most

common sports and trauma-related injuries in orthopaedics, particularly affecting young, active individuals. In India, the incidence has been reported as 68.6 per 100,000 person-years, with sports injuries predominating in urban populations, while road traffic accidents are more frequent causes in rural and semi-urban areas. [4-5]

ACL reconstruction remains the gold standard treatment for complete tears in symptomatic patients, aiming to restore stability and function while preventing further intra-articular damage. Arthroscopic reconstruction with tendon grafts is the preferred method, with graft fixation being critical for successful tendon-to-bone healing. On the tibial side, interference screw fixation is widely accepted, especially with hamstring tendon grafts. [6-8]

Interference screws may be titanium or biodegradable. Titanium screws provide excellent initial fixation strength and biocompatibility but remain as permanent implants, potentially complicating revision surgeries and producing MRI artifacts. Biodegradable screws, made of materials such as polylactic acid or composite polymers, degrade over time, eliminating long-term hardware issues and allowing easier revisions, but concerns exist about inflammatory reactions, cyst formation, and variable degradation rates. [9-12]

Despite extensive use of both screw types, consensus is lacking on superiority regarding clinical outcomes, complications, and cost-effectiveness. This study compares titanium and biodegradable interference screws for tibial fixation in ACL reconstruction to provide clearer clinical guidance. [13-15]

Aim and Objectives: This study aimed to compare the clinical and functional outcomes of titanium and biodegradable interference screws in arthroscopic ACL reconstruction, with assessment by Lysholm Knee Score and International Knee Documentation Committee (IKDC) grading. Complications such as effusion, stiffness, infection, and screw-related issues were also documented.

Materials and Methods

This hospital-based longitudinal, record-based comparative study was conducted in the Department of Orthopaedics, Sardar Patel Medical College, Bikaner, over a period of one and a half years. The study population included patients with ACL rupture who underwent arthroscopic ACL reconstruction using either biodegradable or titanium screws for tibial fixation.

Inclusion criteria were patients aged 18–50 years with ACL rupture unresponsive to conservative treatment. Exclusion criteria included patients with other tibial fixation methods, radiographic evidence of osteoarthritis, associated tibial or femoral fractures, tibial spine avulsion, combined ACL and PCL or meniscal injuries, neuromuscular disorders, or pre-existing deformity/stiff knee.

Patients were selected using consecutive sampling. Sample size was calculated using the formula $N = Z^2p(1-p)/d^2$, based on a reported prevalence of 14.5% ACL injury, with 95% confidence interval

and 10% error, yielding a minimum sample size of 48. After adjusting for 10% non-response, the final sample size was 60 cases, equally divided between biodegradable screw and titanium screw groups.

Data were collected retrospectively from hospital records, including patient demographics, clinical history, examination findings, imaging, operative notes, and follow-up outcomes. All patients were operated after subsidence of pain and swelling, with bracing and analgesics provided preoperatively as needed.

Statistical analysis included descriptive statistics (mean, median, standard deviation, and range) for quantitative variables. Student's t test was applied for continuous data, while Chi-square test was used for categorical variables. A two-sided p value <0.05 was considered statistically significant. Data analysis was performed using Primer version 6.0.

Observations and Results

This comparative study was conducted on 60 patients who underwent arthroscopic anterior cruciate ligament (ACL) reconstruction. Patients were randomly divided into two groups: Group A (biodegradable interference screw, n = 30) and Group B (titanium interference screw, n = 30). The demographic, clinical, and functional outcomes of both groups were compared to assess efficacy and complications.

Demographic Profile: Most patients belonged to the 25–35 years age group, accounting for nearly half of the cases in both groups. Younger patients (<25 years) constituted around 35–40%, while only a small fraction were over 36 years. This reflects the higher prevalence of ACL injuries among young and active individuals. Male predominance was observed, with nearly 80% of patients being males in both groups, consistent with the higher involvement of males in sports and physical labor. Urban residents were slightly more represented (~65%) compared to rural patients, highlighting greater sports participation and easier access to tertiary care facilities in urban areas.

Mode of Injury: Sports injuries were the leading cause of ACL tears, accounting for nearly 60% of cases in both groups, while the rest were due to road traffic accidents (RTA). This distribution underlines the dual burden of lifestyle-related sports injuries in cities and trauma-related injuries in rural and semi-urban populations.

Involved Knee: There was a difference in the side of knee involvement. Group A (biodegradable screw) had a more balanced distribution, with 55% left knees and 45% right knees affected. In contrast, Group B (titanium screw) showed right knee predominance, with almost 85% of cases affecting the right side. Though not clinically significant, this

may reflect dominant limb usage patterns among patients.

Primary Treatment Before Surgery: Around 60% of patients in both groups did not receive any form of primary treatment before undergoing surgery, while the remaining had received supportive care such as bracing, analgesics, or physiotherapy. This indicates that many patients presented directly for surgical management without prolonged conservative treatment.

Pre-Operative Clinical Assessment: The range of motion (ROM) before surgery showed that most patients ($\approx 70\%$) had knee mobility between 100° – 120° , while a smaller proportion could flex beyond 120° . Severe restriction ($<100^{\circ}$) was present in about 15% of patients.

The Lachman test revealed severe knee laxity (Grade 3) in the majority—over 80% in both groups—while the rest had moderate laxity (Grade 2). Similarly, the Anterior Drawer test showed Grade 3 laxity in nearly 80–85% of patients and Grade 2 in the rest. These findings confirm that most patients presented with marked instability requiring surgical intervention.

Post-Operative Clinical Outcomes

Following reconstruction, a significant improvement in knee function and stability was observed in both groups.

- **Range of Motion (ROM):** Over two-thirds of patients in each group regained 120° – 135° knee flexion, indicating near-normal joint mobility. Only 1–2 patients in each group continued to have $<100^{\circ}$ flexion, showing overall favorable functional recovery.
- **Lachman Test:** Postoperatively, around 80–85% of patients demonstrated a negative Lachman test, reflecting restored anterior knee stability. Mild residual laxity (Grade 1) was seen in 10–12%, while moderate laxity persisted in a few patients. Only one patient in the titanium group remained with Grade 3 laxity, showing slightly better outcomes in the biodegradable group for this parameter.
- **Anterior Drawer Test:** Results were consistent with the Lachman test. Approximately 80–88% of patients showed negative results, indicating adequate stabilization. Mild laxity was observed in a small fraction, while only one patient in the biodegradable group had persistent Grade 3 instability.

Functional Outcomes

Functional results were assessed using the Lysholm Knee Scoring Scale and International Knee Documentation Committee (IKDC) grading.

- **Lysholm Score:** In both groups, about 65–70% of patients achieved an Excellent outcome (score 91–100), and 15–20% achieved Good results (84–90). A few patients in each group were graded Fair or Unsatisfactory, but overall functional results were satisfactory in more than 85% of patients.
- **IKDC Grading:** Similarly, the IKDC score demonstrated that over 80% of patients were classified as “Normal” or “Nearly Normal.” A minority of cases were graded Abnormal or Severely Abnormal, without major differences between the two groups.

Complications

Post-operative complications were generally mild and comparable between groups.

- Effusion was slightly higher in the biodegradable group (10–12%) compared to titanium ($\approx 8\%$).
- Hemarthrosis occurred in one patient in the biodegradable group but was absent in titanium cases.
- Knee stiffness was reported in 3–4 patients in each group (≈ 12 – 16%), generally managed with physiotherapy.
- Infections occurred in 1–2 patients per group, managed with antibiotics.
- No cases of screw breakage were recorded in either group.
- Graft loosening was rare, observed in only one patient per group.

Summary of Outcomes

Both biodegradable and titanium screws proved highly effective in restoring knee function and stability following ACL reconstruction. Improvements in ROM, stability tests, and functional scores were significant and largely comparable. Titanium screws showed a marginal advantage in reducing persistent laxity, while biodegradable screws minimized MRI interference and hardware-related concerns. Complication rates were low and not significantly different between the groups.

Table 1: Demographic Summary Table

Parameter	Group A (Biodegradable, n=30)	Group B (Titanium, n=30)
Age Distribution	50% (25–35 yrs), 37% <25 yrs	42% (25–35 yrs), 42% <25 yrs
Gender	80% Male, 20% Female	79% Male, 21% Female
Residence	63% Urban, 37% Rural	67% Urban, 33% Rural
Mode of Injury	58% Sports, 42% RTA	63% Sports, 37% RTA
Involved Knee	55% Left, 45% Right	85% Right, 15% Left

Table 2: Clinical Outcomes Summary Table

Parameter	Group A (Biodegradable, n=30)	Group B (Titanium, n=30)
Pre-op ROM	70% between 100–120°, 15% <100°	70% between 100–120°, 17% <100°
Post-op ROM	71% 120–135°, 4% <100°	67% 120–135°, 8% <100°
Pre-op Lachman	83% Grade 3, 17% Grade 2	79% Grade 3, 21% Grade 2
Post-op Lachman	83% Negative, 13% Grade 1, 4% Grade 2	79% Negative, 8% Grade 1, 8% Grade 2, 4% Grade 3
Pre-op Ant. Drawer	79% Grade 3, 21% Grade 2	88% Grade 3, 12% Grade 2
Post-op Ant. Drawer	79% Negative, 12% Grade 1, 4% Grade 2, 4% Grade 3	88% Negative, 8% Grade 1, 4% Grade 2

Table 3: Functional Outcomes Summary Table

Parameter	Group A (Biodegradable, n=30)	Group B (Titanium, n=30)
Lysholm Score	67% Excellent, 21% Good, 8% Fair, 4% Unsatisfactory	63% Excellent, 17% Good, 13% Fair, 7% Unsatisfactory
IKDC Grade	46% Normal, 42% Nearly Normal, 8% Abnormal, 4% Severe	42% Normal, 38% Nearly Normal, 17% Abnormal, 4% Severe

Table 3: Complication Summary Table

Complication	Group A (Biodegradable, n=30)	Group B (Titanium, n=30)
Effusion	10–12%	~8%
Hemarthrosis	1 case	0
Knee Stiffness	12–13%	16–17%
Infection	1 case	2 cases
Screw Breakage	0	0
Graft Loosening	1 case	1 case

Discussion

This comparative study evaluated biodegradable and titanium interference screws for tibial fixation in arthroscopic ACL reconstruction. Both groups demonstrated significant functional improvement postoperatively, with excellent to good outcomes in the majority of patients, as reflected by Lysholm and IKDC scores. The findings reaffirm the effectiveness of both fixation methods in restoring knee stability and function.

Biomechanical studies have long established titanium screws as the benchmark for strong and reliable fixation. In our study, titanium screws provided marginally better postoperative stability, particularly in anterior drawer and Lachman tests, consistent with the results of Kaeding et al. and Drogset et al., who reported robust fixation with metallic screws. However, biodegradable screws also performed comparably, with most patients achieving excellent stability, aligning with studies by Kotani and Xu et al.

Complication rates were low and largely similar between groups. Biodegradable screws showed a slightly higher incidence of effusion and one case of hemarthrosis, likely due to inflammatory responses from degradation by-products, a concern also highlighted in reviews by Konan and Shen. Conversely, titanium screws had slightly higher rates of stiffness and infection, though these differences were not statistically significant. Importantly, no screw breakage was reported in either group, supporting the safety profile of both materials.

Functionally, more than two-thirds of patients in both groups attained excellent Lysholm scores, and over 80% were graded “Normal” or “Nearly Normal” by IKDC, findings in line with large-scale meta-analyses by Shen and Xu. These results confirm that both screw types deliver durable functional recovery when surgical techniques and rehabilitation are standardized.

Overall, this study supports the view that the choice of screw material should be individualized. Titanium screws may be favored for mechanical

robustness, while biodegradable screws offer advantages in revision surgery and imaging. The outcomes suggest both options remain safe, effective, and clinically comparable.

Conclusion

This comparative study demonstrates that both biodegradable and titanium interference screws are safe and effective for tibial fixation in arthroscopic anterior cruciate ligament (ACL) reconstruction. Patients in both groups showed significant postoperative improvement in range of motion, knee stability, and functional outcomes as measured by Lysholm and IKDC scores. Titanium screws provided slightly superior stability in objective tests and had fewer inflammatory complications, while biodegradable screws offered comparable functional outcomes with the added advantages of being MRI-compatible and eliminating long-term implant-related issues.

Complications such as effusion, stiffness, and infection were infrequent, mild, and manageable, with no cases of screw breakage in either group. Graft loosening was rare and equally distributed. Overall, the choice between biodegradable and titanium screws should be guided by patient-specific requirements, surgeon expertise, implant availability, and long-term goals, particularly with regard to the possibility of revision surgery or the need for artifact-free imaging.

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